Exhibit D

OIF 99-107-01

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Low Cost OC-192 interface based on parallel optics
(OIF99.120)

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Exhibit D

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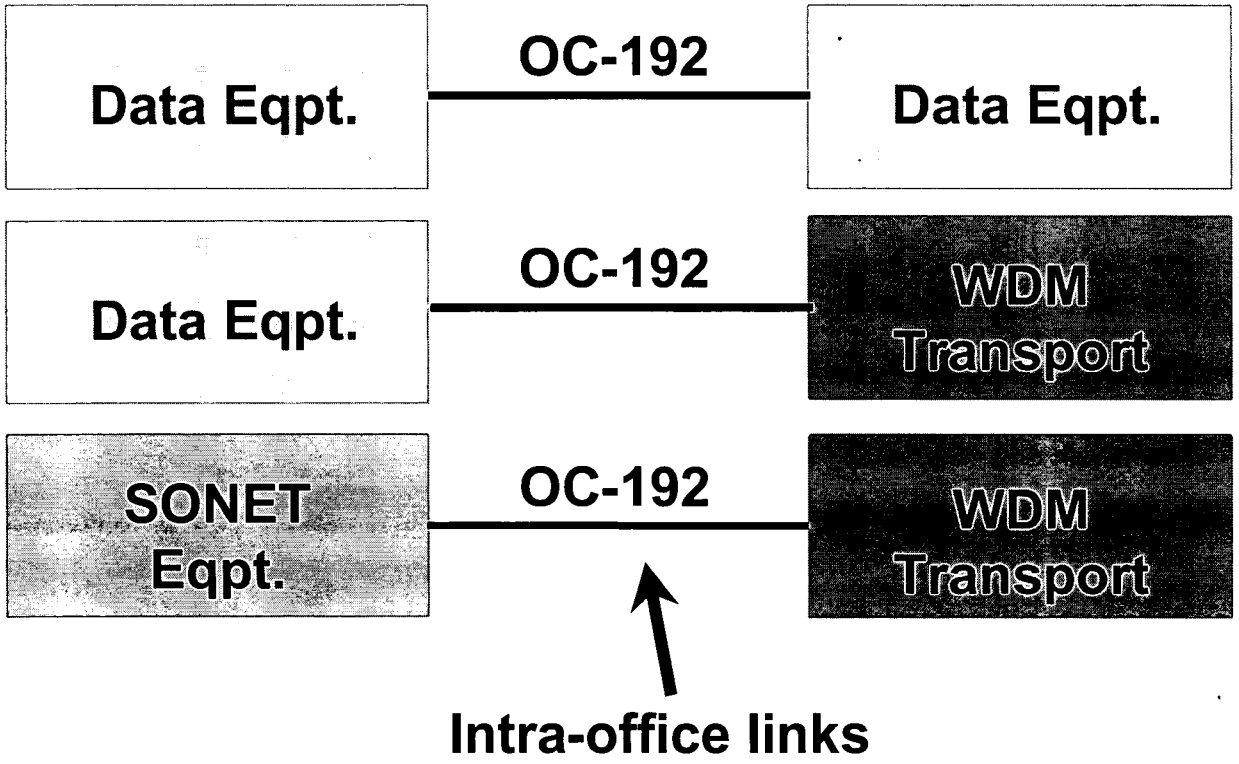
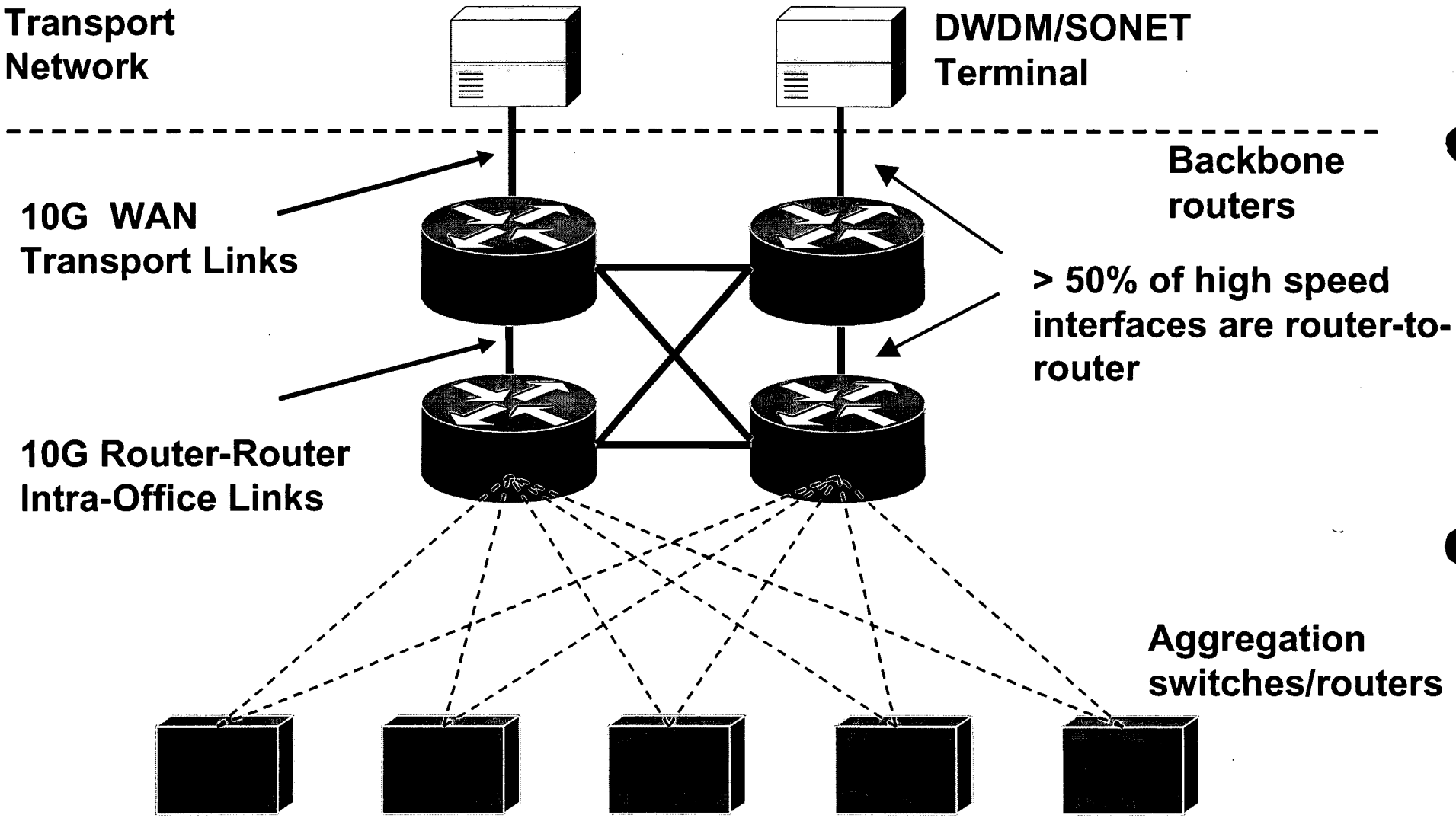
Introduction

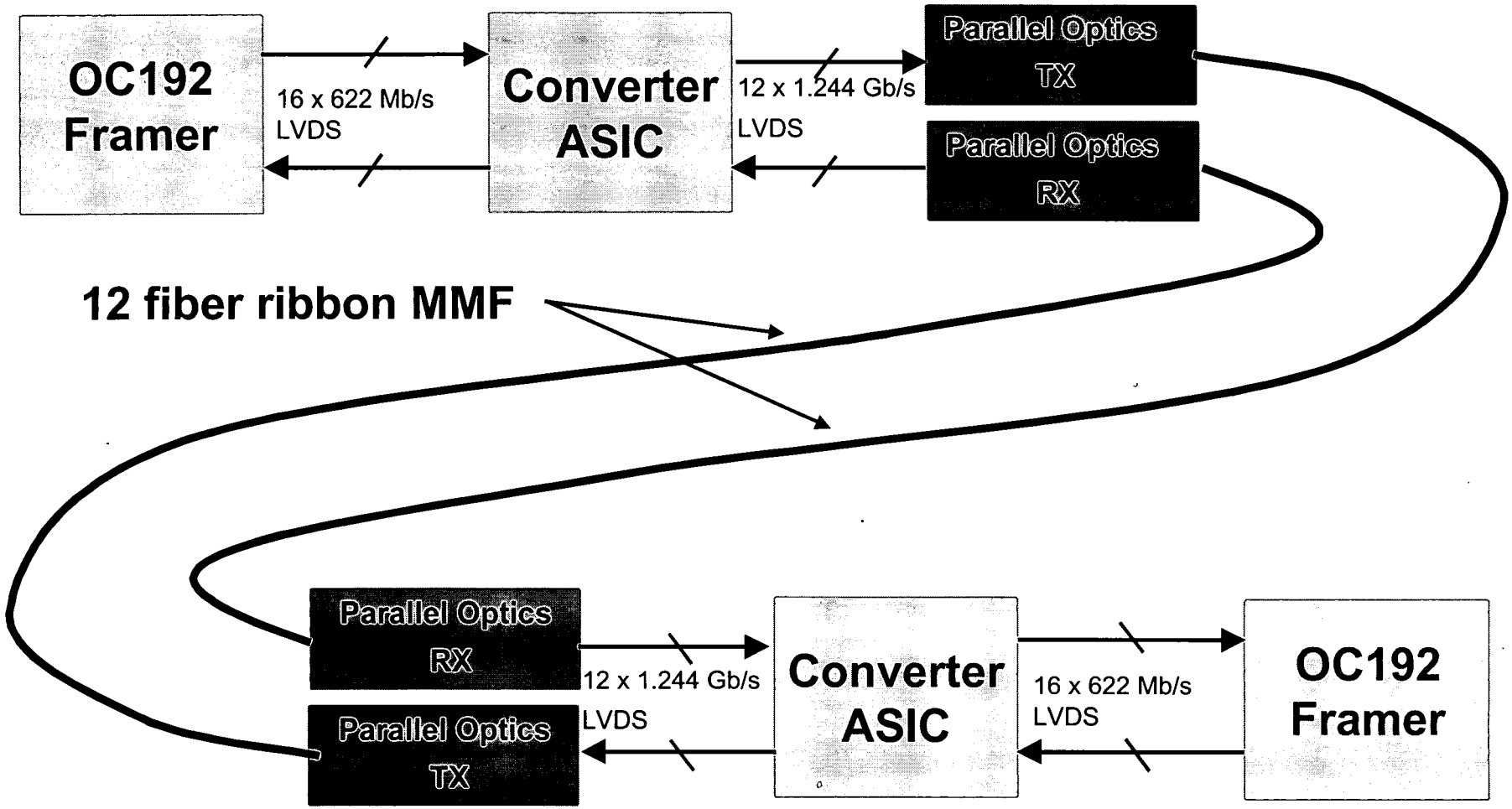


- Majority < 500m, 75% < 100m
- Current OC-192 interfaces optimized for longer reaches

Typical POP Configuration



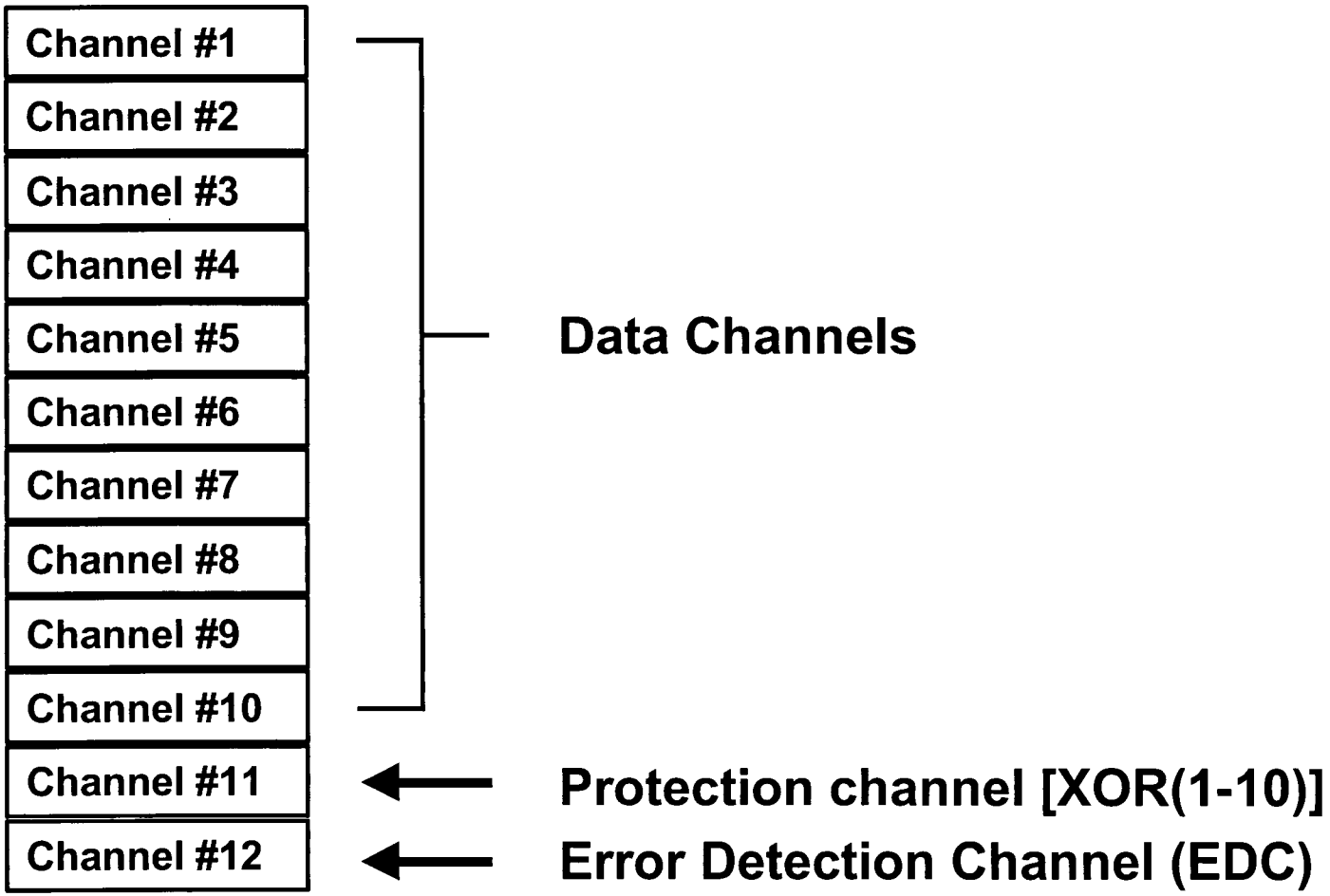
OC-192 VSR Link



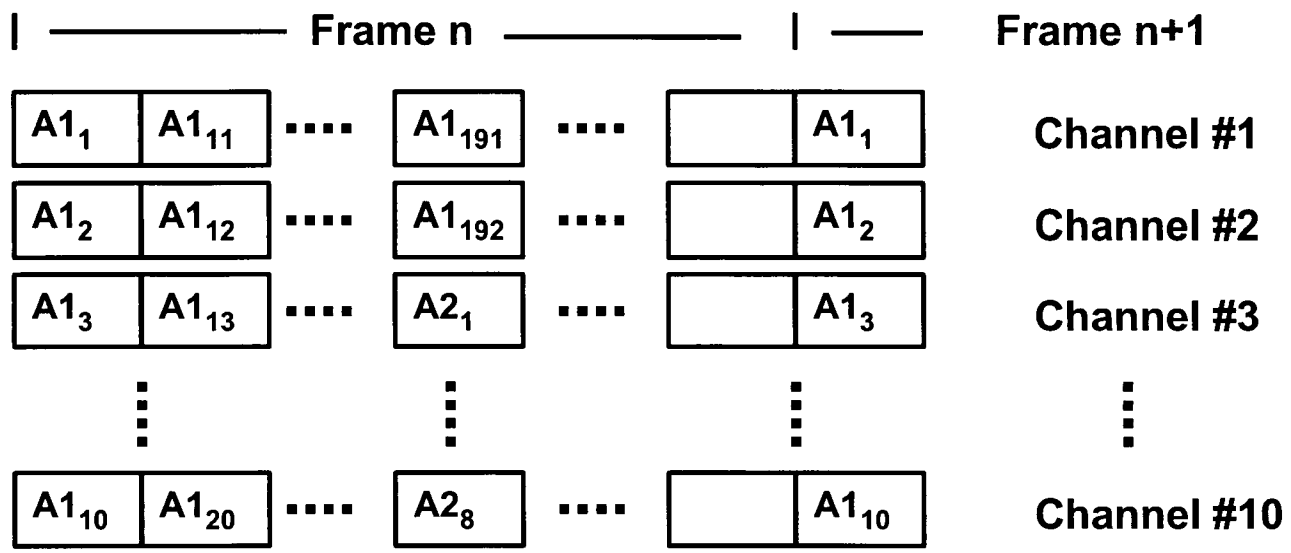
OC-192 Very Short Reach Proposal

- 16 x 622 Mb/s LVDS electrical interface (OIF99.102)
- 12 x 1.244 Gb/s parallel ribbon fiber optical interface
  - leverage Gigabit Ethernet and parallel optical technology
- Converter ASIC maps OC-192 frame onto 10 data channels plus 2 auxiliary channels
  - byte stripping across data channels
  - each channel framed and encoded
  - protection against single channel failure
  - CRC based error detection/correction

OC-192 VSR Channel Format

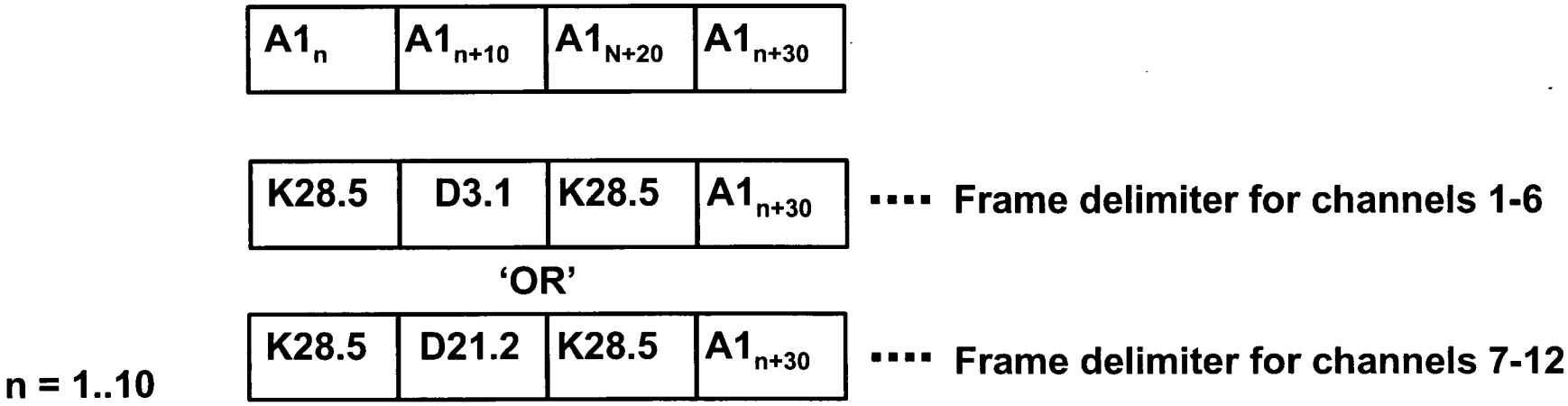


OC-192 VSR Framing



- SONET frame bytes are byte stripped across the 10 data channels
- Each channel is 8B10B encoded to control transmission properties

OC-192 VSR Framing

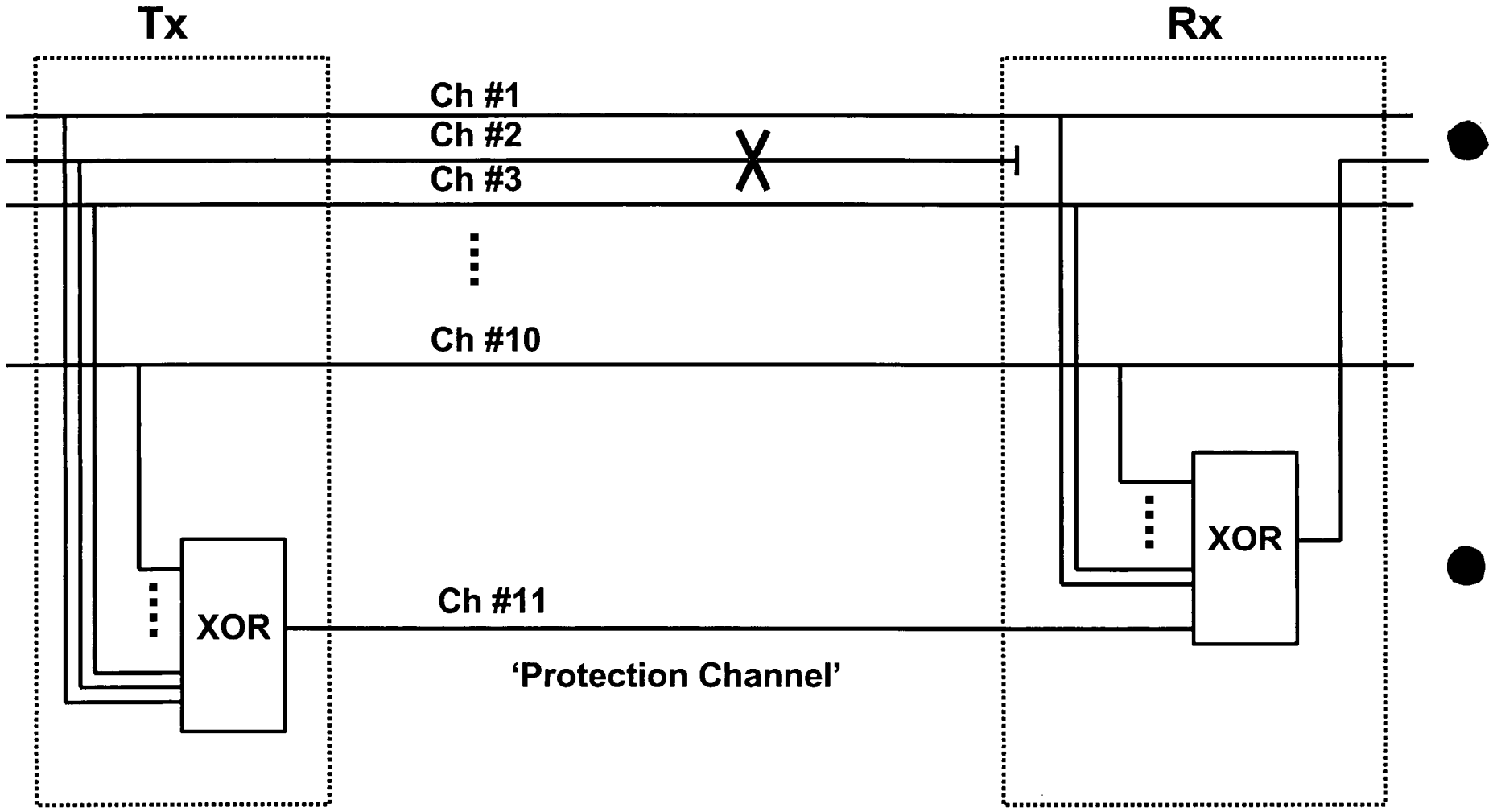


- Each channel is framed with a unique 8B10B frame delimiter pattern that is overwritten onto first 3 A1 bytes on each channel
- Used for de-skewing at the receiver
- Unique frame delimiters for channels 1-6 & 7-12 allow robustness to polarity issues with connector

Protection Channel

- VCSEL arrays have been shown to be very reliable. Dominant failure mechanism is single channel failure
- Protection channel protects against a single channel failure (similar concept to 1:N protection)
- Protection channel carries XOR data from channels 1-10
- If single channel failure is detected, the data can be recovered from the information contained in the XOR channel and the remaining valid data channels
- Protection performed at receiver, no signaling required.

Protection Example

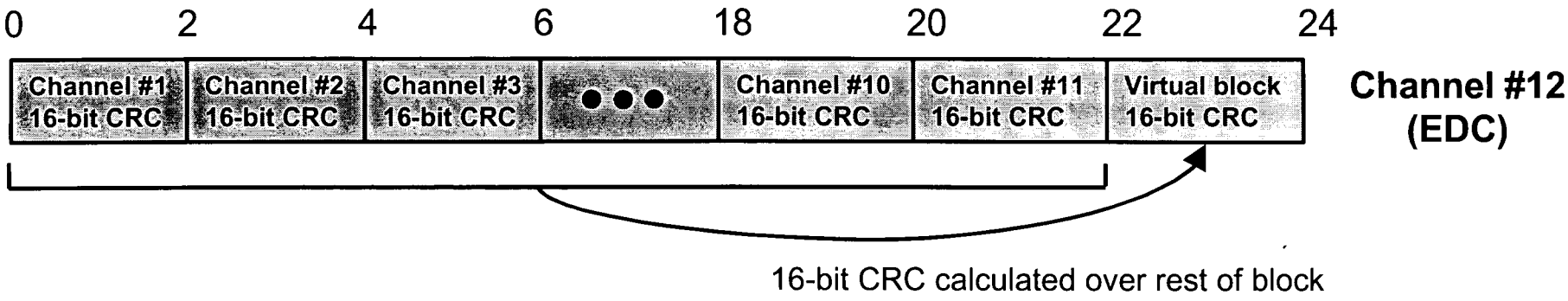


Loss of Synchronization

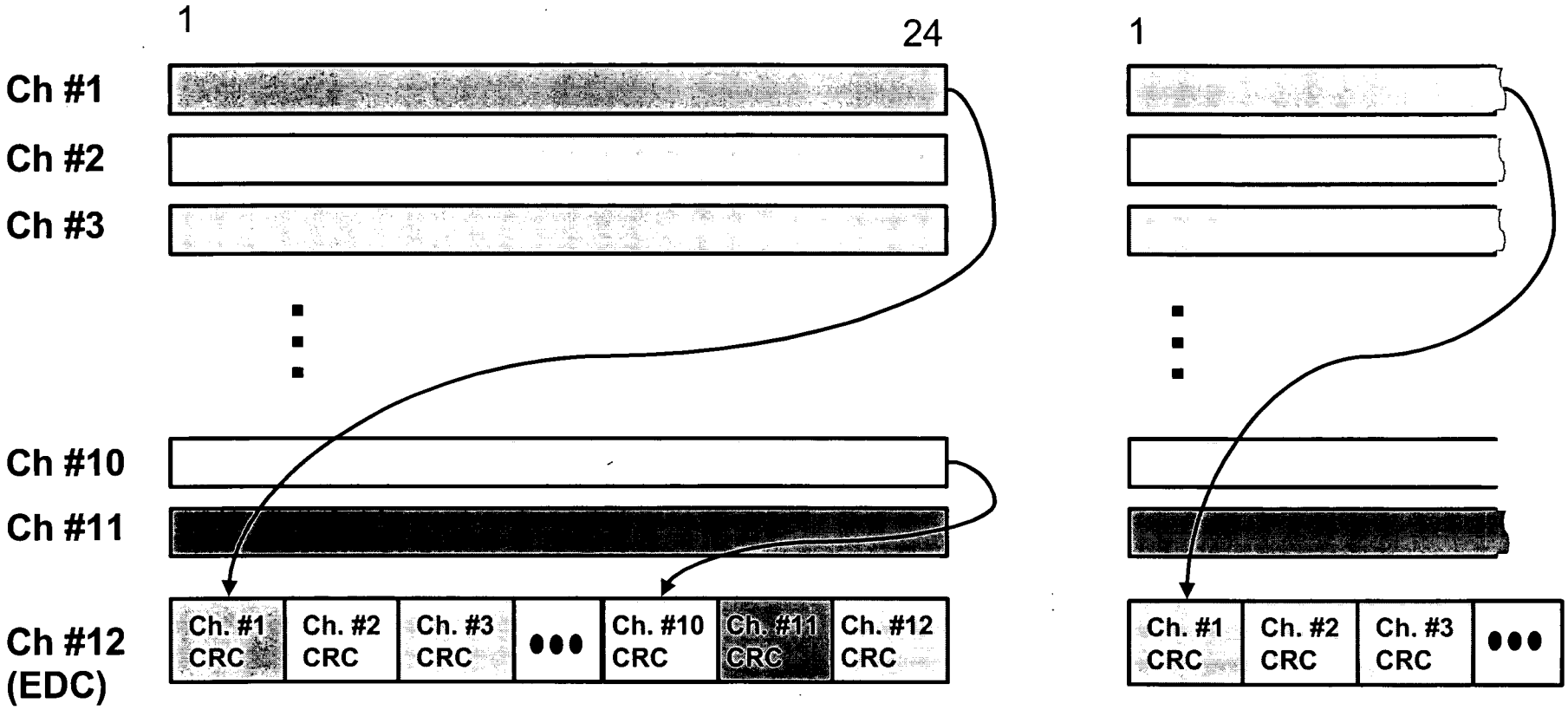
- LOSyn used to determine when single channel failure occurs
- Single channel failure can be detected and protected before any SONET alarms triggered
- LOSyn algorithm based on detecting invalid 8B10B codewords (Similar to Fiber Channel/Gigabit Ethernet)

Error Detection Channel

- Each channel (1-12) divided in virtual blocks of 24 bytes
- 16-bit CRC calculated for each virtual block on channels 1 to 11 (data channels + protection channel)
- the 11 16-bit CRCs are transmitted within the corresponding 24 byte virtual block on the Error detection channel (EDC)
- final two bytes of the EDC virtual block filled with 16-bit CRC calculated over the rest of the virtual block

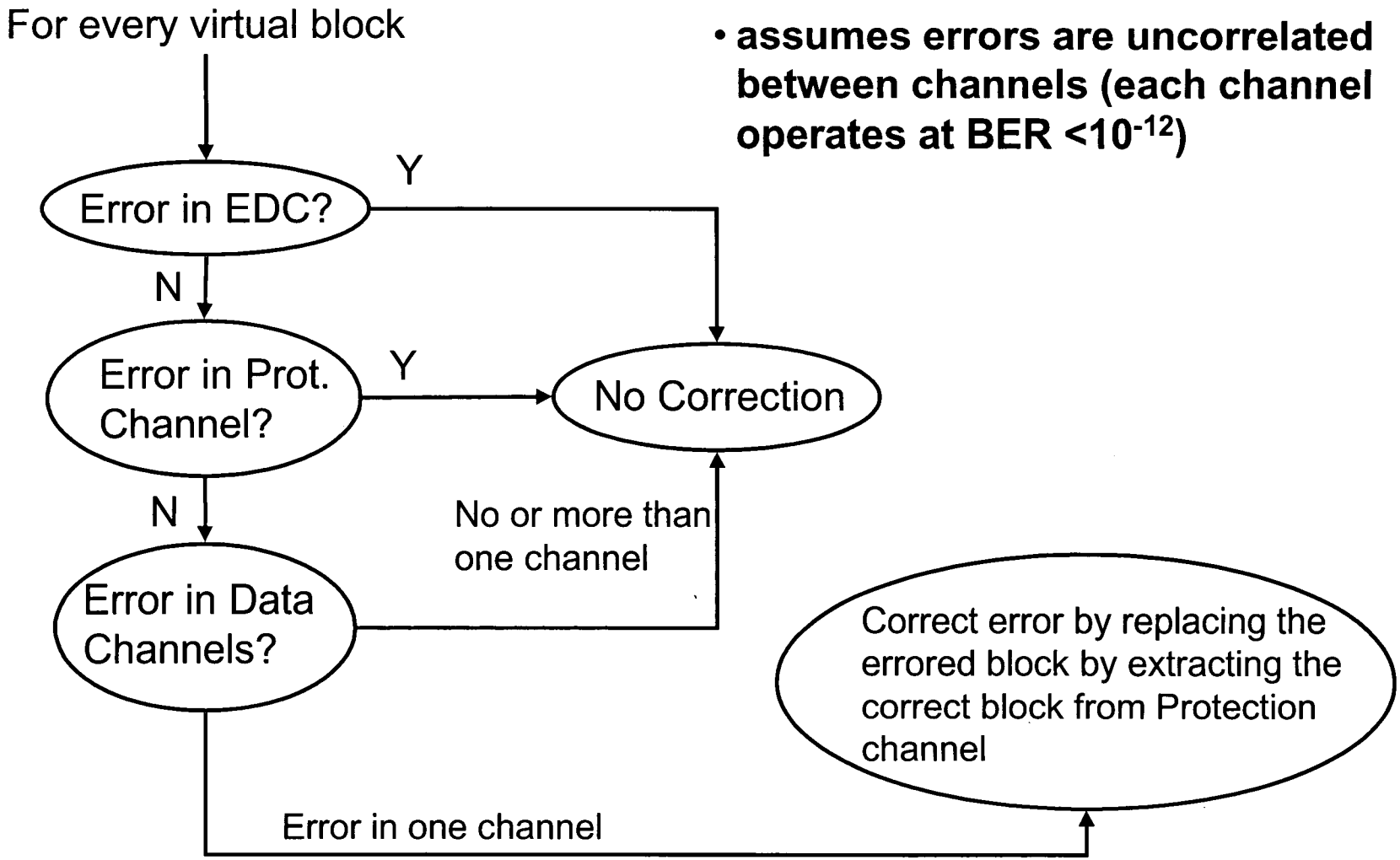


Error Detection Channel



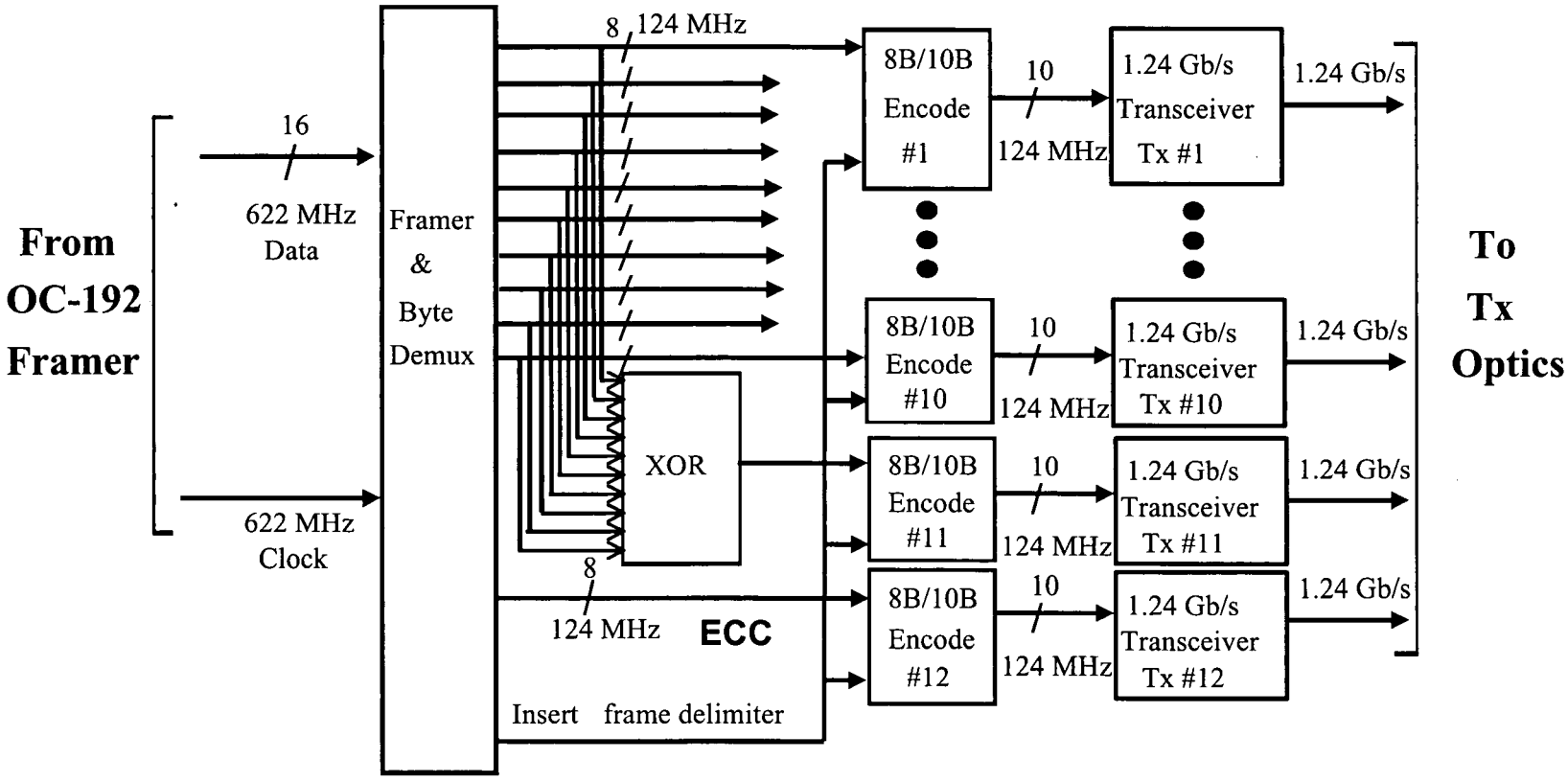
16-bit CRC for every virtual block on each channel is calculated and transmitted within the corresponding virtual block on the EDC

Error Correction

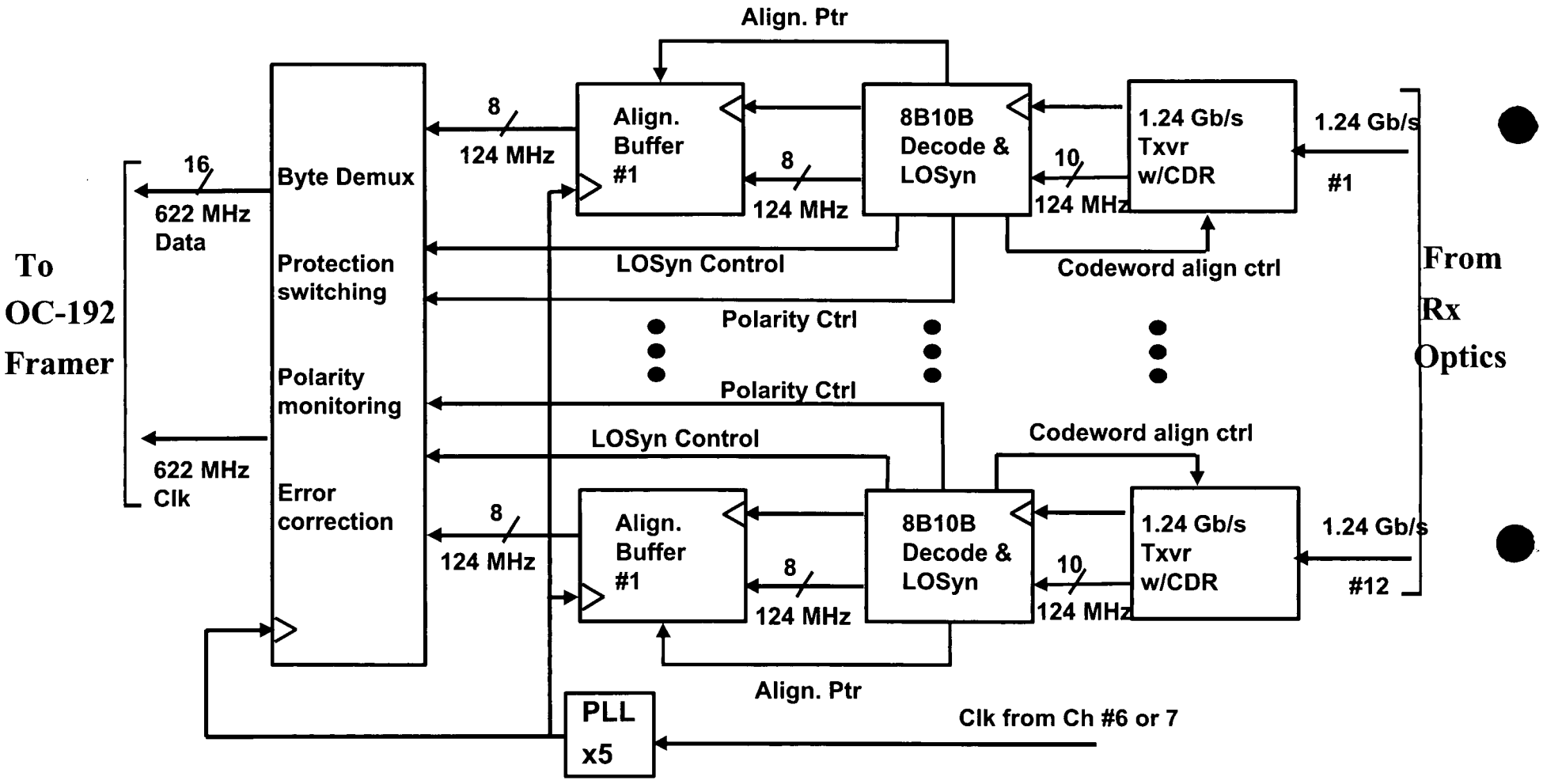


- **assumes errors are uncorrelated between channels (each channel operates at BER <10^{-12})**

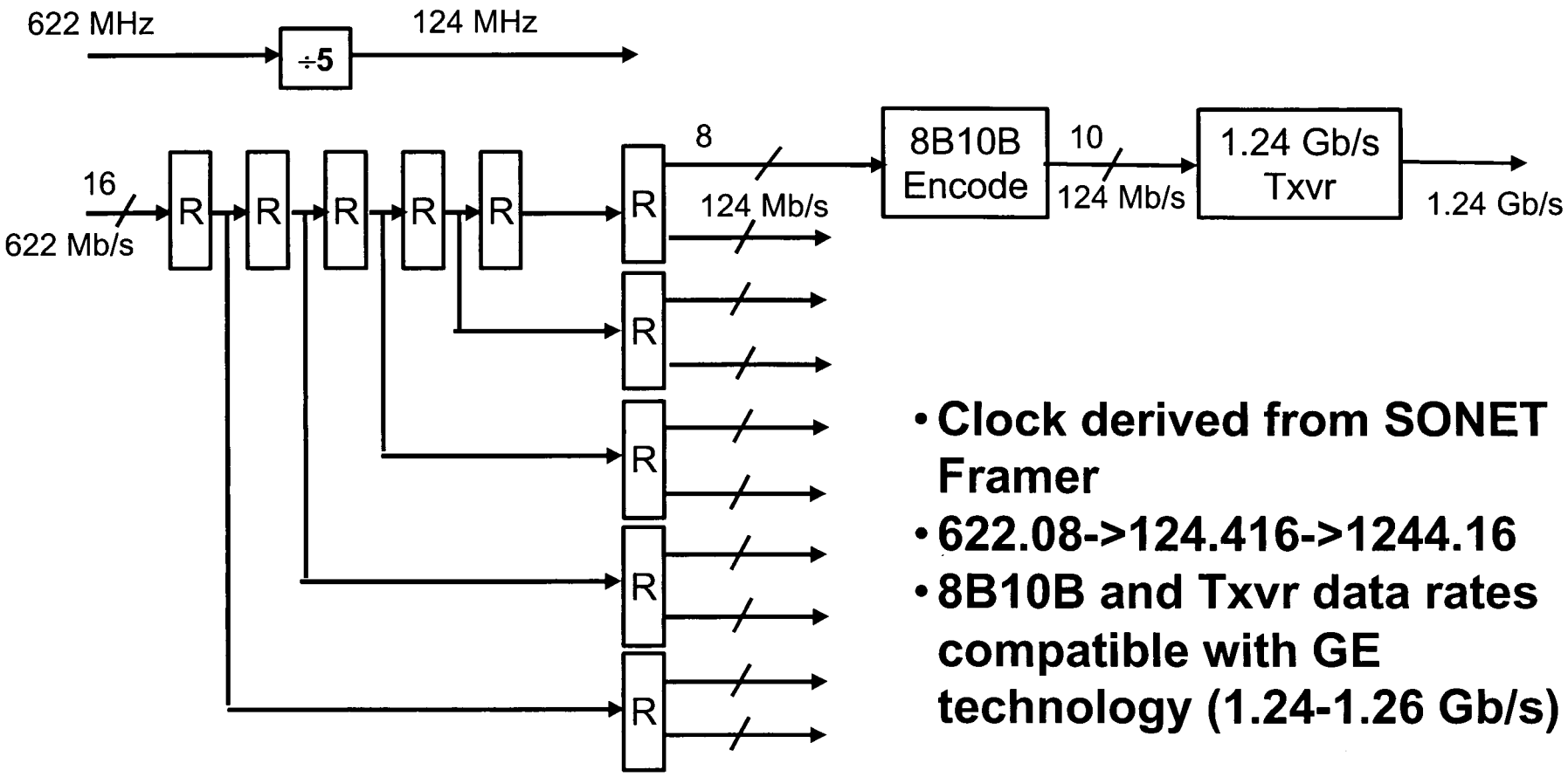
TX Path block diagram



RX Path block diagram



Clocking Scheme



- **Clock derived from SONET Framer**
- **622.08->124.416->1244.16**
- **8B10B and Txvr data rates compatible with GE technology (1.24-1.26 Gb/s)**

OC-192 VSR Optical Specifications

	Min.	Max.	Units
Transmitter			
Baud Rate	1.244 - 20 ppm	1.244 + 20 ppm	Gb/s
λ_{nom}	830	860	nm
Power (out)	-10	See footnote (2)	dBm
Extinction Ratio	6		dB
RMS Spectral Width		0.85	nm
Trise/Tfall (20-80%)		260	ps
Systematic Jitter		160	ps (pp)
Total Jitter		345	ps (pp)
RIN(max)		-116	dB/Hz
Receiver			
Power (in)	-16	0	dBm
λ_{nom}	830	860	dBm
Optical Return Loss	12		dB
Signal Detect assert		-19	dBm
Signal Detect De-assert	-26		dBM
Signal Detect hysteresis	1	4	dB

1. Connector is MTP/MPO (IEC61754-7)
2. Output power for combined channels will be compliant with FDA class 1 and IEC Class 3A eye safety requirements (all channels aggregated)
3. Optical Specifications based on Gigabit Ethernet Link Model

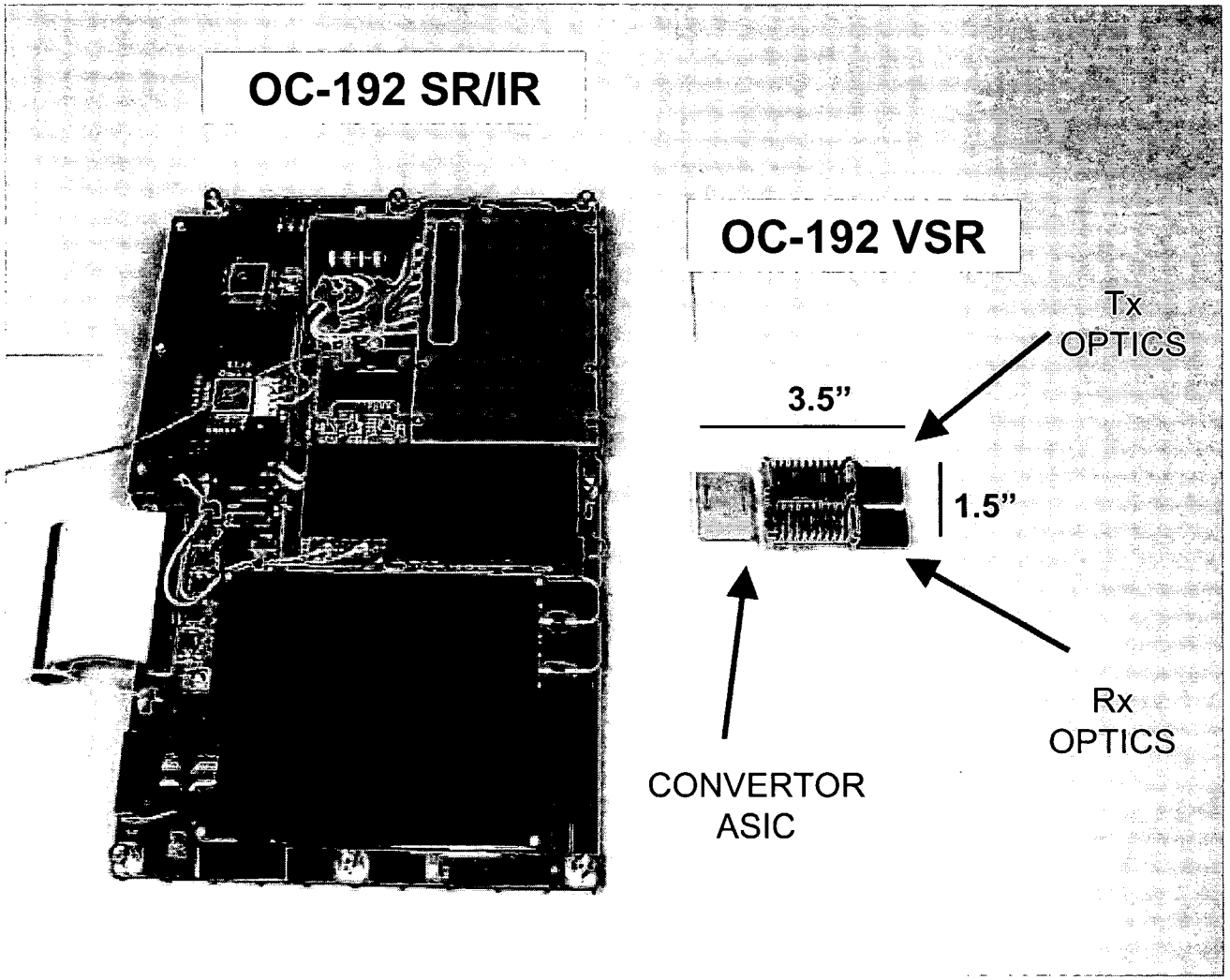
Target Distance Options

Fiber Effective Modal Bandwidth	Target Distance
205 Mhz.km (1)	250m
400 Mhz.km (2)	400m

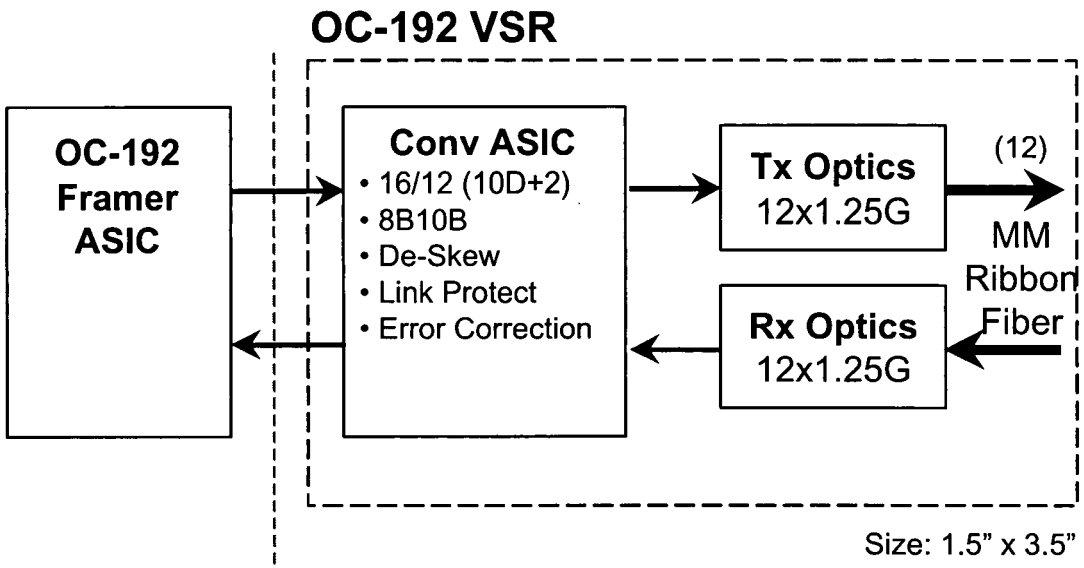
Notes:

1. Fiber which is guaranteed to provide 300m transmission for Gigabit Ethernet operating at 850nm, meets this requirement
2. Fiber which is guaranteed to provide 500m transmission for Gigabit Ethernet operating at 850nm, meets this requirement

VSR Size Comparison



OC-192 VSR Summary



SONET Framed
16x 622Mb/s
(OIF99.102)

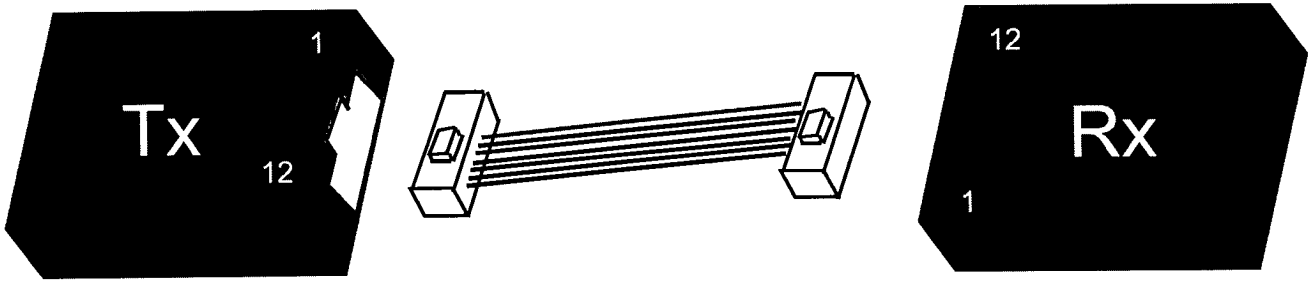
Features:

- **Parallel Optics (based on GE)**
- **Multimode fiber & VCSELs**
  < 250m 62MMF/205MHz.km
  < 400m 62MMF/400MHz.km
- **Compensates for inter-channel skew**
- **Channel protection (1:N)**
- **Error detection/correction**
- **Compatible with OC-192 framer interface (OIF99.102)**
- **Compact form factor**

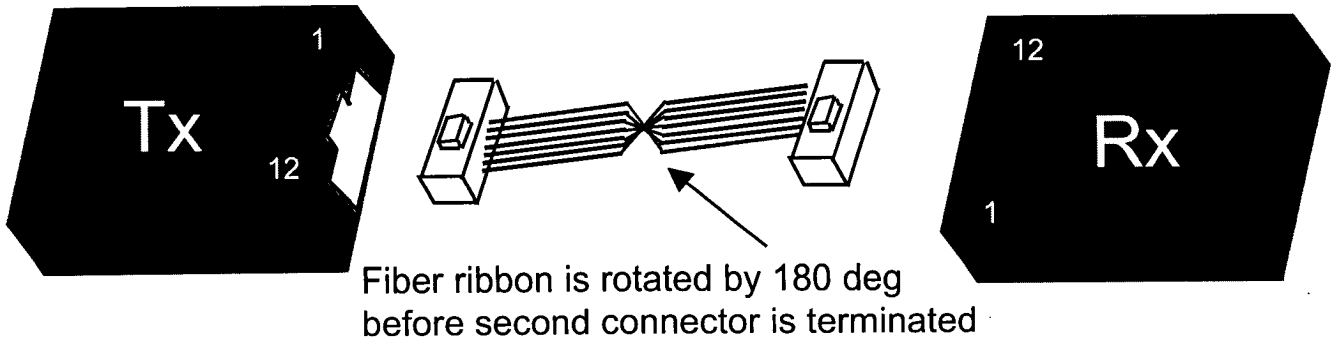
Motion

- **OIF PLL WG to adopt OIF99.120 as a baseline document for the development of a specification for an OC-192 very short reach interface based on parallel optics.**

Polarity and cable crossover



Option 1: Ribbon Fiber cables are connected back to back. Implication is that Tx channel #1 is connected to Rx channel #12.



Option 2: Ribbon Fiber cables are connectorised with a rotation on the fiber. Implication is that Tx channel #1 is connected to Rx channel #1.